Space Weather Technical Forecast

Issued on Wednesday, 17 August 2022 at 00:15 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: G1/Minor storm likely Days 1 and 2 (17-18 Aug), chance of G2/Moderate storm. Further Moderate flares (R1-R2 Radio blackouts) likely throughout. Active electron fluence likely declining.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity is Moderate with two M-class flares in the last 24 hours. These were from AR3078 (Dkc/Beta-Gamma-Delta) in the southwest quadrant, the largest an M5.0 at 16/0758 UTC. There are currently ten sunspot regions on the visible disc. AR3078 is the largest and most active region and is displaying strong spots with a weak delta configuration. AR3081 is the next largest region on the disc, but has been relatively stable. AR3083 has grown in recent hours. Three regions are approaching the west limb, with another couple of weak regions becoming visible in the southeast. Most other regions appear largely small and stable for now. There are two main CMEs which left the Sun between the 14th and 16th that have potential to reach Earth on 17th and 18th. The M5 flare did produce a CME, but this appears likely to mostly pass below Earth. The most recent M-flare may also have produced a CME but we await imagery to assess this.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, has shown a decline to slow-ambient levels. Wind speeds declined from around 420km/s to vary between 350-380 km/s. Density has been at average or below average levels, but has been rising recently. The IMF was weak throughout although with a recent increase to 7nT, with the north-south component varying weakly (+7/-3nT). The phi angle was positive (away from the Sun) until 16/1100 UTC when it switched to negative. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured by GOES16, was at Background levels. The high energy electron flux (greater than 2 MeV) was High, with a peak of 6.04e3 pfu at 16/2305 UTC. The 24-hour integrated electron fluence was above the Active threshold throughout on a steady trend, with an observed value of 2.62e8 integrated pfu at 17/0000UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be Moderate with a slight chance of High levels. The most likely source region for any larger flares would be from AR3078, which is now in the southwest quadrant.

Solar Wind / Geomagnetic Activity: There are two main CME arrivals likely during this period. The first left the Sun on 14 August and is likely to arrive around 17/0600 UTC, +/-12 hours. A second CME left the Sun on 16 August and may give a glancing blow at Earth either late on 18 or early on 19 August. Solar winds are currently at slow-ambient levels. Later on Day 1 (17 Aug) Earth is expected to connect with the high speed stream from coronal hole 14, although this is likely to combine with the aforementioned first CME. Wind speeds are likely to reach elevated levels at around 500-600km/s. Solar winds are expected to remain enhanced through much of

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this period before perhaps declining somewhat through Day 4 (20 Aug).
Geomagnetic activity is expected to be mainly Quiet at first. During Day 1, activity is expected to become Active to G1/Minor Storm, with a chance of G2/Moderate Storm and a slight chance of G3/Strong Storms, most likely when the first CME mentioned above affects Earth. A gradual decline in activity is expected through Day 4.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at background levels, although with a slight chance of an S1 or greater event mainly due to AR3078.
High energy electron flux will start at high levels, but various CME and HSS arrivals from Day 1 through to Day 3 (17-19 Aug) are likely to suppress flux levels. A rise is possible once again on Day 4 (20 Aug). Electron fluence values will start above the Active (1e8 integrated pfu) threshold, but are likely to drop sharply with the expected CME arrival, probably below Active levels. They are most likely to stay below during Days 2 and 3, perhaps with a rise on Day 4.

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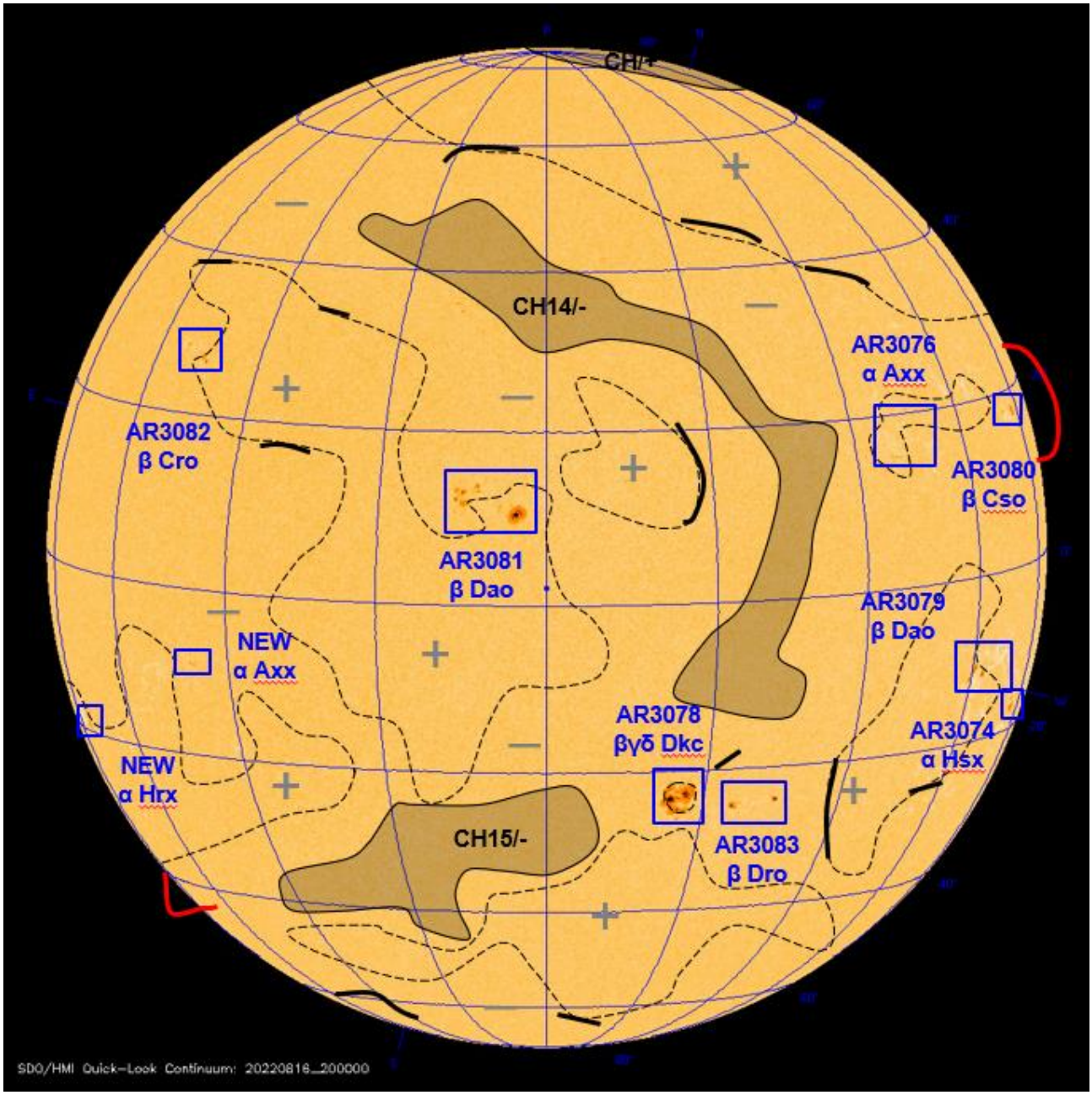
Figure 1. Solar Analysis Valid 16/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are two main CME arrivals likely during this period, although there have been several CMEs in recent days that may give peripheral effects. The first left the Sun on 14 August and is likely to arrive around 17/0600 UTC, +/-12 hours. A second CME left the Sun on 16 August and may give a glancing blow at Earth either late on 18 or early on 19 August, although the bulk of the ejecta is likely to pass below Earth. Solar winds are currently at slow-ambient levels. Later on Day 1 (17 Aug) Earth is expected to connect with the high speed stream from coronal hole 14, although this is likely to combine with the aforementioned first CME. This coronal hole is a recurrent feature and solar winds are indicated by persistence to reach elevated levels at around 500-600km/s. Solar winds are expected to remain enhanced through much of this period with the HSS and also with the possible arrival of a second CME Day 2 into Day 3 (18-19 Aug). Wind speeds then perhaps declining somewhat through Day 4 (20 Aug).

Geomagnetic activity is expected to be mainly Quiet at first. During Day 1, activity is expected to become Active to G1/Minor Storm, with a chance of G2/Moderate Storm and a slight chance of G3/Strong Storms, most likely when the first CME mentioned above affects Earth. A gradual decline in activity is expected through Day 4.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	50	40	5
Strong	G3	No	20	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1747	Partial	AR3076	NW quadrant	620	17/0600 UTC +/-12 hours	Long period C-flare
16/0740	Partial	AR3078	South centre disc	607	19/0001 UTC +/-12 hours	Glancing blow possible

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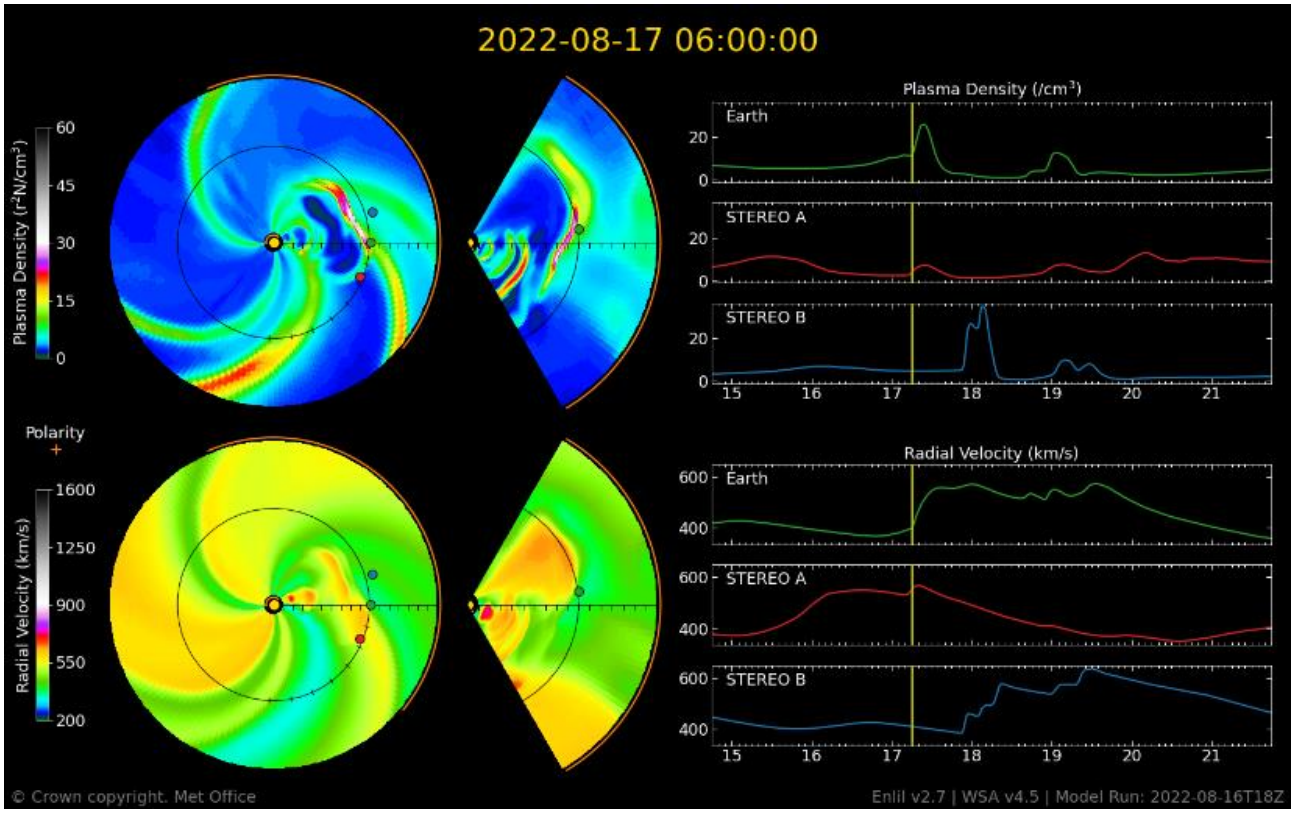
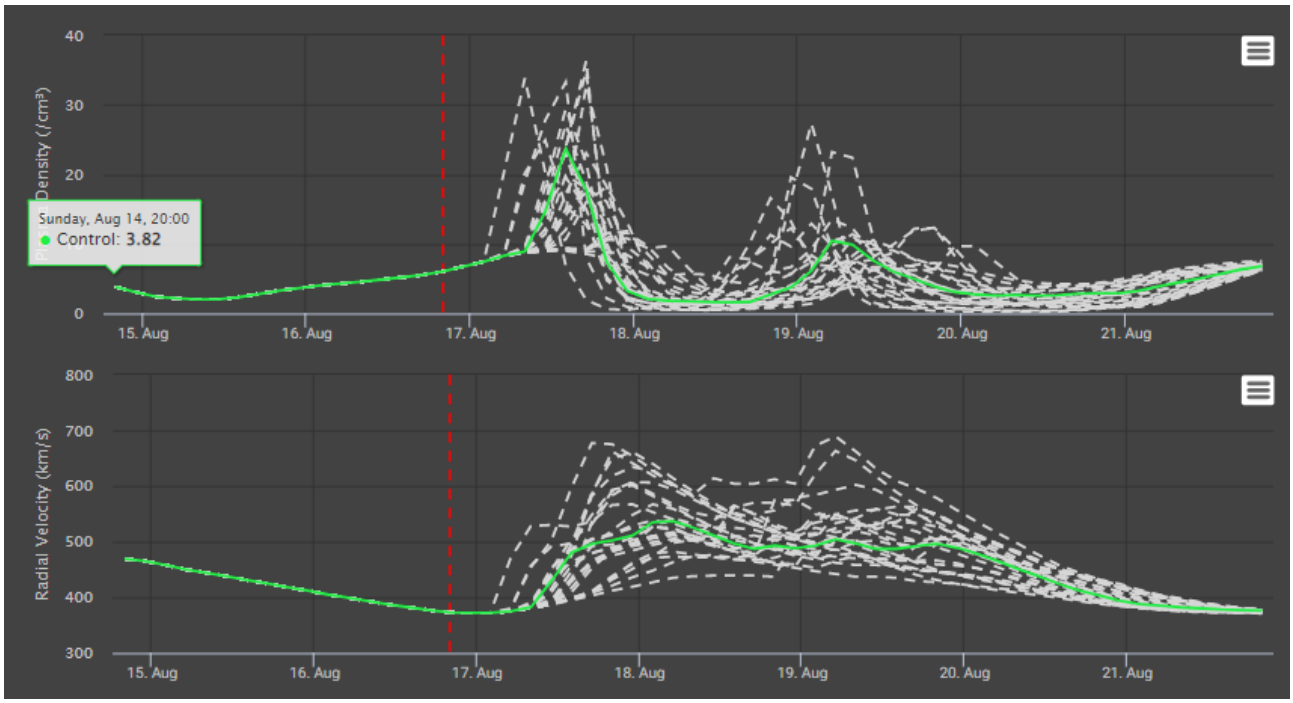
Figure 2: MOSWOC Enlil and ensembles, showing 2 potential CME arrivals. The ensemble spread gives an indication of the large amount of uncertainty.





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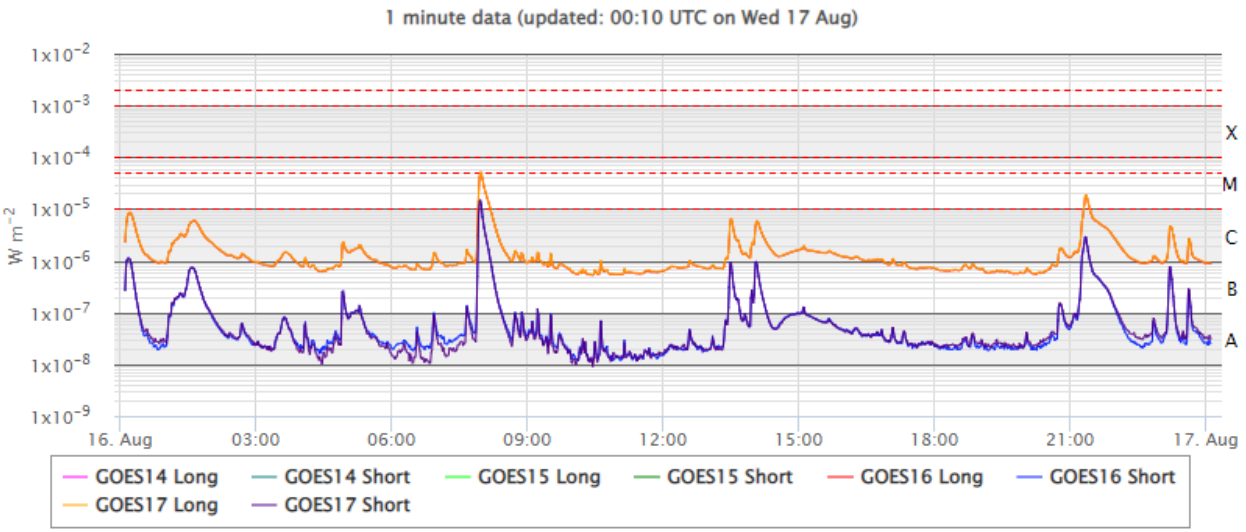
Radio Blackouts - X-Ray Flares:
Solar activity is currently Moderate, mainly due to activity from AR3078 (Dkc/Beta-Gamma-Delta). Activity is likely to remain Moderate, with a slight chance of becoming High over the coming days. There are also other candidates for flaring that need to be considered given their size, namely AR3081 (Dao/Beta) near north centre disc and AR3079 (Dao/Beta) in the southwest. However, these areas have significantly less magnetic complexity than AR3078 and as such have a lower flare risk. AR3083 has also shown some development in recent hours. Other regions appear to be stable or in decay. There is a very slight reduction in risk on Day 4 (20 Aug) as AR3079 will be well over the west limb by this time, but as the main flare risk comes from AR3078 the reduction is only small.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	60	60	50
Very Active	R3 to R5 X Class	No	15	15	15	15

Figure 3: Recent flaring, mostly from AR3078.



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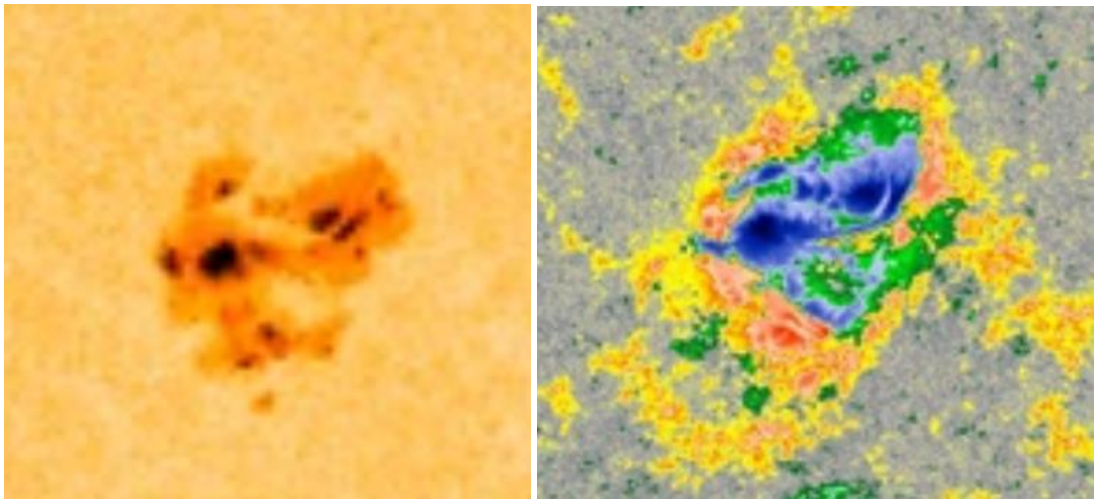
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently at Background levels, and is likely to remain at this level through the period. AR3078 carries the main, albeit slight, risk of proton events and as it transits further westward, the risk increases very slightly through the period. There is a very small contribution to the risk from AR3079 and AR3081.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	15	15	15
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: The magnetic complexity of AR3078 makes it the most likely candidate to give a proton event.



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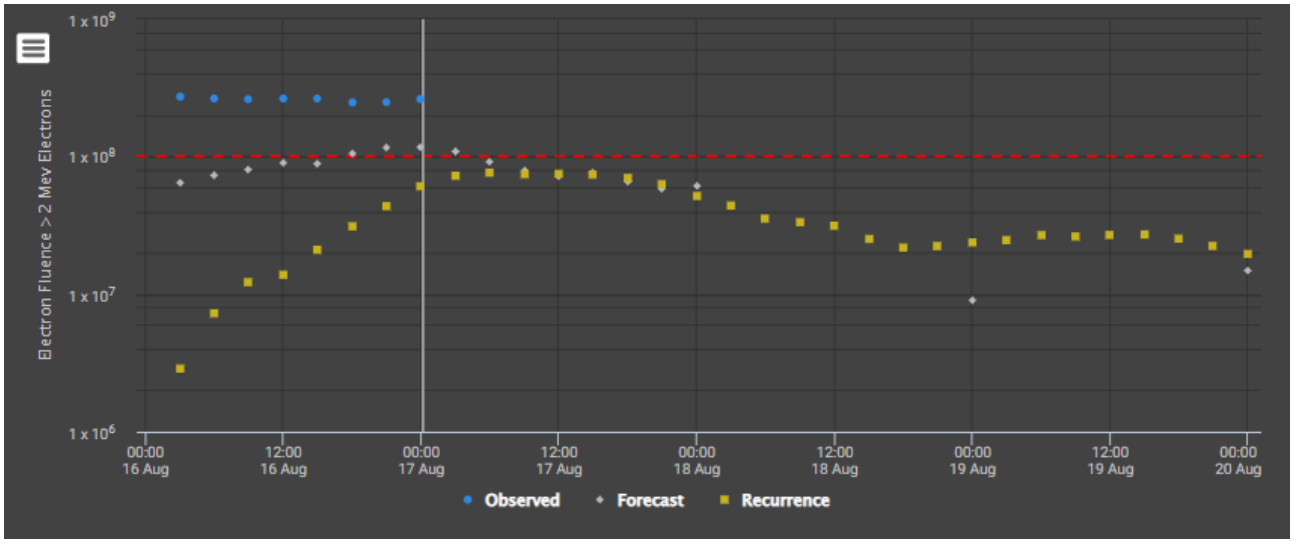
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) will start the period at high levels. During Day 1 (17 Aug) a CME and HSS arrival is expected which is likely to suppress flux levels due to both geomagnetic effects and deformation of the van Allen belt. A further potential CME arrival later Day 2 or early Day 3 (18-19 Aug) may continue the suppressed flux levels. A rise is possible once again on Day 4 (20 Aug) as geomagnetic activity begins to subside.

Electron fluence values will start above the Active (1e8 integrated pfu) threshold, but are likely to drop sharply with the expected CME arrival, probably below Active levels. They are most likely to stay below during Days 2 and 3, perhaps with a rise on Day 4. REFM forecast values are currently too low, and this model won't be taking account of the likely CME arrivals. As such although it is forecasting a decline and looks like it is currently showing a trend in line with the forecast above, this will be for the wrong reasons and therefore REFM should not be relied upon through this period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	40	20	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM. Although it shows a declining trend, this is due to the model forecasting the high speed stream decline in fluence and does not represent the sharp drop out expected from a CME arrival.



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